Christopher A. Ashe Physics 344: Professional Statement December 8th 2013

Purdue University, the Electrical and Computer Engineering department, and the Physics department equip students with many exceptional skills that allow graduates to have superior success in far-reaching areas research. As a graduate of both the Physics department and Electrical Engineering department, I have gained valuable skills and experience with many intellectual and physical systems that will allow me to participate in the vanguard of research. The focus of my undergraduate studies has been microelectronics and nanotechnology. The core of this concentration can be roughly encompassed in three courses: ECE 305 semiconductor devices, ECE 453 Fundamentals of nanotechnology taught by Supriyo Datta, and Physics 360 Quantum mechanics. These courses will be vital in graduate work with nontechnology.

Purdue not only produces exceptional graduates, it also has a history of pushing technology further through innovative research. It was Purdue's Physics department that produced high quality germanium used by Bell labs during the development of the transistor and nearly independently developed the transistor. Without this breakthrough, ten percent of the world economy would not directly exist and industries that relay on the machines built with semiconductors would be a fraction of what they are. We have built our lives around the skillful implementation of group IV and group III/V of the periodic table. The basic architecture of the transistor, whether it be a metal oxide field effect transistor or a bipolar junction transistor has remained relativity constant while integrated circuits have revolutionized our lives.

As Moore's law advances through time and holds true, novel ways of sinking the transistor will have to continually be created. A paradigm shift in transistor technology has been made available by means of spinFETs, proposed by Supriyo Datta and Biswajit Das in 1990. In this architecture the drain and source terminals are ferromagnetic and the channel is a two dimensional electron gas, most likely constructed from graphene. Spin-polarized electrons can pass through the channel from the source to the drain, arriving with a different polarization state because of the Rashda Effect. The rate at which electrons travel through the channel is governed by the electric field in the channel which is controlled by the gate voltage. The electric current following from drain to source is described by the difference between the carrier's polarization angle and the drain's polarization angle. The angular difference is dependent on the electron flow rate; therefore the spinFET is controlled by gate voltage, characteristic of field effect transistors.

The physical realization of spinFETs is proposed to have a number of district advantages. Their prime advantage is that data storage devices will be able to be built more compactly because spin states can be detected and changed without electric current. The independence from current allows the memory cells to be non-volatile.

There are many areas to research before the spinFET can be realized such as spin current effiency, transport behavior of spin polarized electrons in 2DEG, spin polariztion retention, material boundray behavior, and ferromagnetism at room temperature. These questions are compelling and require much effort to elucidate. I believe that my undergraduate studies have prepared me for continued intellectual progress in microelectronics. I feel that I will be able to contribute to a further understanding of spintronics-based technology.

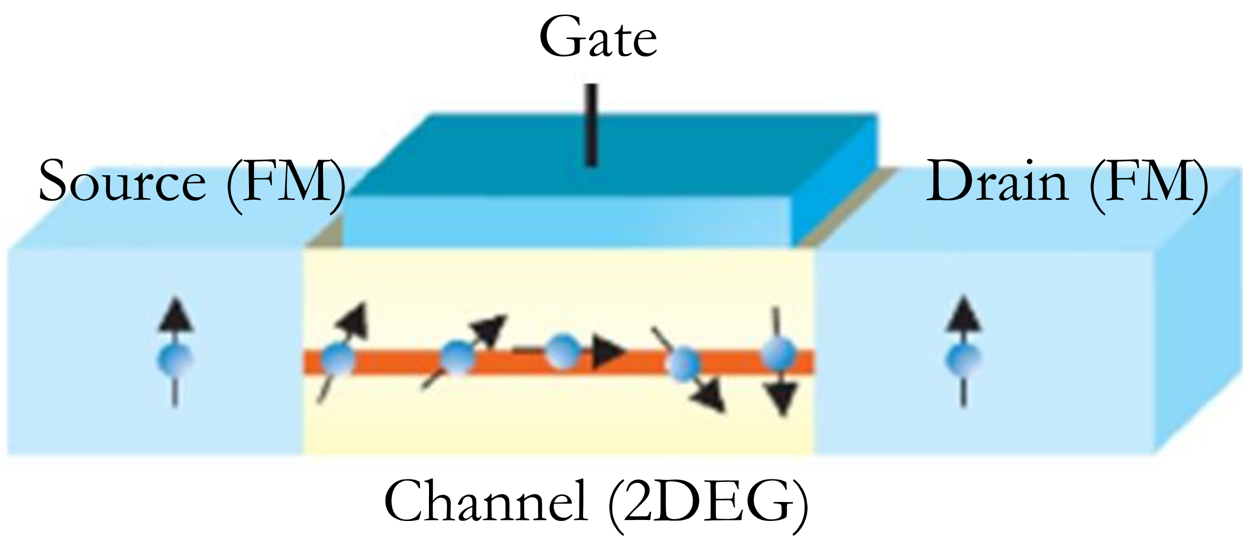

Figure 1: Proposed spinFET Architecture